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THE INFLUENCE OF PHOSPHORUS FERTILIZER RATE ON GROWTH, YIELD AND SOME COMPETITIVE INDICES OF CORIANDER AND FENUGREEK IN ROW INTERCROPPING SYSTEM

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ABSTRACT: To evaluate the influence of different phosphorus fertilizer rate (0.0, 15, 30 and 45 kg P_2O_5/feddan) and intercropping systems (sole planting of both crops as control, 1: 1, 2: 2 and 2: 3 as row ratio between coriander: fenugreek, respectively), a field experiment was done at a Privet Farm, Abo-Hammad District, Sharkia Governorate, Egypt. This experiment was established during 2023/ 2024 and 2024/2025 seasons. The main plot was occupied with intercropping systems and the subplot was occupied with phosphorus fertilizer in a split plot design with three replicates. The results cleared that the tallest coriander and fenugreek plants were obtained under 2: 2 intercropping system compared to the other systems under study. The highest coriander branch number and heaviest herb dry weight and fruit yield per plant were noticed when 2 coriander rows alternated with 3 fenugreek rows intercropping system. Under the same intercropping system (2: 3 system), fenugreek plant recorded the highest pods number and seed yield per plant compared to the other intercropping systems. Fertilizing coriander and fenugreek plants with 45 kg P_2O_5/feddan significantly increased growth and yield traits compared to any phosphorus rate under study. In general, the highest land equivalent ratio (1.35 and 1.39) values were obtained under 2: 3 system. The best combination treatment regard LER (1.43 and 1.41) was 2: 3 combined with 15 kg P_2O_5/feddan. Coriander plants were a predominant component (it has a positive signs), while, fenugreek plants were defeated one (it has a negative signs).

Key wards: Coriander, fenugreek, intercropping, phosphorus, growth, yield, LER.

INTRODUCTION

Egypt is one of the biggest constructors, consumers and exporters of aromatic and therapeutic spices worldwide. Coriander (*Coriander sativum*), commonly referred to as "Cosbara," is a one of the Apiaceae family. In Egypt, coriander is mainly grown in Behera, Gharbia, Menoufia, Beni Suef, Menia, New valley and Noubaria (**Statistics of the Ministry of Agriculture, 2024**). **Arslan *et al.* (2002)** stated that coriander is grown extensively in Algeria, Morocco, Tunisia, Iran and South American nations and southern European countries. Fresh coriander is rich in vitamin A, B_2, and C and is widely utilized in salads, seasonings, chutneys, and soups (**Lokesh *et al*., 2018**). Coriander was also utilized to treat regulate digestion, colds, diarrhea and get rid of gas, prevent high arteriosclerosis and blood pressure, lower blood sugar levels and cholesterol, treat anemia and fungal infections. It also particular a significant role in the treatment of anemia as well as it is utilized to treat rheumatism due to its calcium content (**Erdogdu, 2012**).

Fenugreek (*Trigonella foenum-graceum* L.), commonly referred to as "Helba" is a one of the Leguminosae family. In Egypt, Fenugreek is mainly grown in New valley (**Statistics of the Ministry of Agriculture, 2024**). Numerous benefits of fenugreek have been noted in traditional medicine, including anti-cancer anti-inflammatory and analgesic properties as well as

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reducing blood lipids and cholesterol to treat diabetes (**Mandegary *et al.*, 2012**). The two most significant metabolites of fenugreek, trigonelline and nicotinic acid, are potent blood cholesterol and diabetic treatments. Fenugreek grains are regarded as feed plants because of their high nutritional value and are also utilized to boost animal milk (**Basch *et al.*, 2003**).

Intercropping is a direction to improve variation in an agricultural ecosystem. As an illustration of sustainable agricultural systems, intercropping aims to achieve ecological balance, increase resource use, improve quality and quantity, and lessen yield damage from weeds, pests, and diseases. A number of agronomic practices that influence species combinations can be utilized to assess the success of intercrops in contrast to solid cropping. These procedures include intercropping models, planting dates, final densities and resource availability (**Gliessman, 1997**; **Mazaheri *et al.*, 2006; Glaze-Corcoran *et al.*, 2020**). Given the significance of vegetable intercropping and the necessity to double farmers' income due to current demand and the fact that fenugreek is the primary crop in intercropping systems, a study on fenugreek-based vegetable intercropping must be undertaken. Legumes allow for more efficient use of land and other resources, which lowers production costs. It is urgently necessary to increase agricultural output through intercropping at a low cost in order to feed the growing population (**Verma *et al.*, 2021**).

One of the main goals of agriculture is to enhance yield. Consequently, plant nutrition - both macro and micro - plays a significant role in crop production (**Dogramaci and Arabaci, 2015**). In plant production, growth and yield are negatively impacted by either more or less fertilizer. Additionally, fertilizer has a significant role in aromatic and medicinal plants. Fertilization methods and dosages have an impact on secondary metabolites and yield measures (**Srinivasaro, 2021**). In cultivated crops, phosphorus (P) is one of the most important macronutrients for plant growth (**Zand *et al.*, 2013**). According to **Khalid (2012)**, phosphorus is essential for plant metabolism, including cell division, flower commencement, and fruit or seed maturation. Also, **Sonmez (2018)** pointed out that the 60 kg ha^{-1} phosphorus application produced the largest number of seeds per umbel, 1000-seed weight and essential oil content.

The primary goal of this research is to determine how different phosphorus fertilization rates and intercropping systems between coriander and fenugreek affect the growth and yield components of both crops as well as some competitive indices of both components in the Sharkia Governorate.

MATERIALS AND METHODS

A field experiment was done during 2023/2024 and 2024/2025 seasons at a Privet Farm, Abo-Hammad District, Sharkia Governorate, Egypt, to evaluate the influence of different phosphorus fertilizer rate (0.0, 15, 30 and 45 kg P_2O_5/feddan) and intercropping systems (sole planting of both crops as control, 1: 1, 2: 2 and 2: 3 as row ratio between coriander: fenugreek, respectively) on growth, yield and some competitive indices between them. Table 1 lists the chemical and physical characteristics of the mixture of the two soil types that were used according to **Chapman and Pratt (1978).**

Table 1. Physical and chemical properties of experimental soil (average of two seasons)

physical properties									Soil texture
Clay (%)			Silt (%)			Sand (%)			Clayly
58.37			24.72			16.91			
Chemical properties									
E.C. dSm^{-1}	pH	$CaCO_3$ (%)	Organic matter (%)	Soluble cations (meq./ L)				Soluble anions (meq. /L)		
				Ca^{++}	Mg^{++}	Na^{+}	K^{+}	HCO_3^-	Cl^-	SO_4^{--}
2.27	7.87	0.39	1.07	12.18	9.77	6.14	5.43	7.88	7.17	18.47
Available nutrient (mg kg^{-1}soil)										
N		P	K		Fe		Zn	Mn		Cu
36.42		29.74	180.50		1.71		0.59	0.39		0.60

Cultivation

The experimental unit included 12 ridges spaced 60 cm apart, coriander plants (two plants per hill) planted in two side of the ridge at a distance of 30 cm, fenugreek plants sown in both sides of the row, with 30 cm distance. Coriander fruits and fenugreek seeds were sown on 24th and 29th October in both winter seasons of 2023/2024 and 2024/2025. The intercropping systems were sole planting of each crop as control, 1ridge of coriander alternating with 1 ridge of fenugreek (1: 1 system), 2 ridges of coriander alternating with 2 ridges of fenugreek (2: 2 system) and 2 ridges of coriander alternating with 3 ridges of fenugreek (2: 3 system). The intercropping systems were distributed as main plot. The various phosphorus rates (0.0, 15, 30 and 45 P_2O_5/ feddan) were added as soil drench through the experimental preparation. The phosphorus fertilizer source was super calcium phosphate (15 % P_2O_5) and it was arranged at sub-plots.

At 30, 45 to 60 days after sowing, three equal portions of various rates of N and K fertilizers - potassium sulfate (48% K_2O) and ammonium sulphate (20.6%N) - were divided. When necessary, the two crops (coriander and fenugreek) received normal agricultural procedures (irrigation, fertilization, disease and pest resistance, etc.).

Experimental Design

The statistical layout of this experiment was split-plot design between intercropping system (four systems) and phosphorus fertilizer rate (four rates) plot in a complete randomized block design with three replicates. The main plot was occupied with intercropping systems and the subplot with phosphorus fertilizer. This experiment included 16 treatments.

Data recorded

Vegetative traits: A random sample of nine plants from every plot was taken after 85 days from sowing. The plant height (cm), herb dry weight /plant, branches number on both crops were noticed through both growing seasons.

Yield components: A random sample of nine plants from inner ridges of every plot was taken after 157 days (coriander) and 110 days (fenugreek) from sowing date. The umbels number/coriander plant, pods number/ fenugreek plant as well as seed yield per plant and per feddan of both crops were recorded through the two seasons.

Competitive indices:

Land equivalent ratio (LER) was determined for coriander and fenugreek yield calculated per feddan according to the following equation:

LER = Lc + Lf

$$Lc = \frac{Ycf}{Ycc} \quad , \quad Lf = \frac{Yfc}{Yff}$$

Where, Ycc and Yff are the yields per feddan of coriander and fenugreek, respectively, as sole crops, Ycf, and Yfc are the yields of coriander and fenugreek, respectively, as intercrops (**Mead and Willey, 1980**).

Aggressivity (A) value was calculated according to **Mc Gilchrist (1965)** equation as follows:

$$Acf = \frac{Ycf}{Ycc \times Zcf} - \frac{Yfc}{Yff \times Zfc} \quad ,$$

$$Afc = \frac{Yfc}{Yff \times Zfc} - \frac{Ycf}{Ycc \times Zcf}$$

Where, Ycf = Intercrop yield of coriander, Yfc = Intercrop yield of fenugreek, Ycc = Sole yield of coriander, Yff = Sole yield of fenugreek, Zcf = Sowing proportion of coriander and Zfc = Sowing proportion of fenugreek.

Statistical Analysis:

The recorded data were statistically analyzed according to **Gomez and Gomez (1984)**, and the recorded means were compared utilizing Statistix software version 9 **(Analytical software, 2008).**

RESULTS AND DISCUSSION

Growth traits of Both Components

Intercropping influence

Results recorded in Table 2 show that there were significant increase between intercropping systems and sole coriander planting in plant height, branch number and herb dry weight in both seasons. Utilizing 2 ridges of coriander: 3

ridges of fenugreek significantly recorded a higher number of branches (17.42 and 17.75 branches/plant) and dry herb weight (32.84 and 33.42 g/plant) in comparison with the other systems under study. Moreover, all intercropping systems significantly decrease fenugreek height compared to sole crop in most cases in both seasons (Table 3). Whenever, the highest branch number of fenugreek was noticed with 2: 3 intercropping systems compared to the other systems and solid planting in the two seasons. There were no significant differences between sole crop and intercropping system in herb dry weight in 1st season.

These results supported the widely held belief that plants gain from the direct transfer of fixed N2 in legume/non-legume intercropping systems (Graham and Vance, 2000). In addition, similar results were reported by Abdelkader and Hassan (2016) on dill when intercropped with fenugreek, Boori et al. (2018) on fennel when intercropped with fenugreek and Dubey et al. (2023) on chilli when intercropped with fenugreek.

Phosphorus influence

As listed in Tables 2 and 3 it is clear that increasing coriander plant height (122.00 and 125.58 cm), branches number per plant (16.08 and 16.58) and herb dry weight (24.38 and 25.28 g) as well as fenugreek height (58.75 and 59.58 cm), branches number (16.42 and 17.67) and herb dry weight (8.82 and 9.00 g) were achieved from the highest phosphorus fertilizer rate (45.00 P2O5 kg/ feddan) in 1st and 2nd seasons, respectively .

Table 2. Impact of intercropping system, phosphorus rate and their combination treatments on growth traits of coriander plant during both seasons

Treatments		Plant height (cm)		Branch number/ plant		Herb dry weight (g)	
		1st season	2nd season	1st season	2nd season	1st season	2nd season
Effect of intercropping system (Coriander row: Fenugreek row)							
Sole coriander		112.50	117.75	8.58	8.00	8.39	8.12
1: 1		121.25	124.58	11.08	12.00	19.52	19.77
2: 2		127.17	130.00	15.50	16.17	27.85	26.74
2: 3		113.67	118.08	17.42	17.75	32.84	33.42
LSD at 5%		**4.33**	**3.35**	**1.77**	**1.34**	**1.24**	**0.40**
Effect of phosphorus fertilizer rate (kg P_2O_5 /feddan)							
Control		115.83	118.33	10.17	10.25	19.46	19.04
15		118.25	121.25	11.83	12.33	22.01	21.32
30		118.50	125.25	14.50	14.75	22.75	22.40
45		122.00	125.58	16.08	16.58	24.38	25.28
LSD at 5%		**2.20**	**2.16**	**0.66**	**0.96**	**0.65**	**0.43**
Effect of intercropping system × phosphorus fertilizer rate							
Sole coriander	**Control**	112.33	115.00	5.67	5.00	7.00	6.67
	15	113.33	118.67	6.67	5.33	8.10	7.67
	30	112.33	120.33	9.33	9.00	9.13	8.17
	45	112.00	117.00	12.67	12.67	9.33	9.97
1: 1	**Control**	116.33	118.00	7.33	7.33	17.03	16.40
	15	116.00	121.00	9.33	11.67	19.17	18.73
	30	125.00	128.33	13.00	13.67	20.20	20.63
	45	127.67	131.00	14.67	15.33	21.67	23.30
2: 2	**Control**	123.67	126.33	12.67	13.67	26.47	25.03
	15	127.00	129.33	14.33	15.00	28.10	25.40
	30	130.00	133.00	17.00	17.33	28.17	26.90
	45	128.00	131.33	18.00	18.67	28.67	29.63
2: 3	**Control**	111.00	114.00	15.00	15.00	27.33	28.07
	15	116.67	116.00	17.00	17.33	32.67	33.47
	30	106.67	119.33	18.67	19.00	33.50	33.90
	45	120.33	123.00	19.00	19.67	37.87	38.23
LSD at 5%		**5.75**	**5.01**	**2.10**	**2.13**	**1.67**	**0.84**

Due to phosphorus is a component of the molecular structure of critical substances like DNA and RNA, it has exceptional impacts on the growth parameters of coriander and fenugreek plants (**Marshner, 1995**). It is also vital for meristem tissues, cell division and photosynthesis. Because legumes have a higher capacity for phosphorus use than other crops, several forms of phosphate fertilizers are applied to the soil to correct the P shortfall (**Gentili *et al.*, 2006**). Moreover, **Hossain and Pariari (2018)** and **Abdelkader *et al.* (2023)** on coriander as well as **Gour *et al.* (2011)** and **Ahmed (2025)** on fenugreek reported similar results.

Combination between intercropping and phosphorus influence

The most values of growth traits of both components (coriander and fenugreek) were linked to alternating two ridges of coriander with three ridges of fenugreek, along with 45 kg P_2O_5/ feddan consumption of calcium superphosphate, according to a comparison of the combination influence between intercropping systems and phosphorus fertilizer rates (Tables 2 and 3). In most cases, all combination treatments significantly increased branches number and herb dry weight of both crops compared to sole planting without phosphorus fertilizer application in both seasons. Furthermore, these obtained results in accordance with those pointed out by **Abusuwar and Omer (2011)** on *Clitoria ternatea* inter-cropped with *Lablab purpureus* and fertilizing with phosphorus and **Abdelkader and Hassan (2016)** on dill when intercropped with fenugreek and combined with phosphorus fertilization.

Yield traits of Both Components

Intercropping influence

Results presented in Tables 4 and 5 demonstrate that increasing ridges number of fenugreek from 2 to 3 under 2 ridges of coriander increased fruits and seed yield of coriander and fenugreek per plant, respectively. Under 2: 3 intercropping system fenugreek plant recorded the highest pods number compared to the other intercropping systems. Also, alternating two ridges of coriander with three ridges of fenugreek treatment (2: 3) significantly enhanced fruit (16.61 and 16.51 g/ coriander plant) or seed (10.91 and 11.08 g/fenugreek plant) yield compared with the other intercropping system under study in the tested seasons. All intercropping system significantly decreased fruit and seed yield per feddan compared to sole crop of both plants in both seasons. **Odhiambo and Ariga (2001)** indicated that when maize and beans were interplanted in varying systems, the production improved because there was less competition between the two species as opposed to within. Likewise, **Garshasbi *et al.* (2023)** on chicory intercropped with fenugreek noticed the same results.

Phosphorus influence

When phosphorus was applied at a rate of 45 kg P_2O_5 per feddan, the number of umbels and pods, as well as the fruit and seed yield per plant and per feddan of coriander and fenugreek, respectively, significantly increased during both seasons when compared to the other phosphorus rates under investigation (Tables 4 and 5). In general, as phosphorus fertilizer rates increased, the aforementioned traits gradually increased as well. Furthermore, phosphorus is necessary for the general health and vigorous growth of all plants. Several specific factors have been linked to phosphorus, including improved flower formation and seed production, increased nitrogen fixing capacity of legumes, improved crop quality, resistance to plant disease, and increased stack and stem strength (**Abadi *et al*., 2015**). These results are in agreement with those stated by **Hossain and Pariari (2018)** and **Abdelkader *et al.* (2023)** on coriander as well as **Gour *et al.* (2011)** and **Ahmed (2025)** on fenugreek.

Combination between intercropping and phosphorus influence

The results recorded in Tables 4 and 5 shows that, fruit and seed yield per feddan of coriander and fenugreek, respectively, significantly increased with the combination treatment of sole crop combined with 45 kg P_2O_5 per feddan of phosphorus fertilizer compared to the other combinations under study. On the contrary, umbels number and fruit yield per coriander plant as well as pods number and seed yield per fenugreek plant was significantly enhanced with all combinations between intercropping system

and rates of phosphorus in comparison with control (sole crop and without application of phosphorus) in most cases. Furthermore, as phosphorus fertilization rates increased, so did the yield components of both crops under each treatment of intercropping systems. These results were consistent with those of a study conducted by **Abdelkader and Hassan (2016)** on phosphorus-fertilized dill intercropped with fenugreek.

Table 3. Impact of intercropping system, phosphorus rate and their combination treatments on growth traits of fenugreek plant during both seasons

Treatments		Plant height (cm)		Branch number/ plant		Herb dry weight (g)	
		1st season	2nd season	1st season	2nd season	1st season	2nd season
Effect of intercropping system (Coriander row: Fenugreek row)							
Sole fenugreek		60.25	60.42	13.17	13.92	7.82	8.04
1: 1		54.92	58.83	14.67	15.25	8.34	8.33
2: 2		57.08	57.58	13.92	15.67	8.24	7.70
2: 3		53.75	51.08	16 .42	17.33	7.93	8.07
LSD at 5%		**2.05**	**2.39**	**0.99**	**0.86**	**N.S.**	**0.39**
Effect of phosphorus fertilizer rate (kg P_2O_5 /feddan)							
Control		56.50	54.25	12.75	12.75	6.79	6.92
15		52.58	53.92	14.67	14.92	7.87	7.80
30		58.17	58.17	13.92	16.83	8.85	8.40
45		58.75	59.58	16.42	17.67	8.82	9.00
LSD at 5%		**2.40**	**2.21**	**1.18**	**1.02**	**0.42**	**0.24**
Effect of intercropping system × phosphorus fertilizer rate							
Sole fenugreek	**Control**	66.33	61.00	10.33	10.00	6.27	6.73
	15	57.33	56.33	14.00	13.67	7.57	7.50
	30	62.33	63.00	13.67	16.00	8.97	8.67
	45	55.00	61.33	14.67	16.00	8.50	9.23
1: 1	**Control**	53.67	53.00	13.67	13.33	7.97	7.37
	15	50.00	54.33	13.67	14.33	7.94	8.13
	30	58.33	59.00	15.67	16.33	8.53	8.60
	45	57.67	61.00	15.67	17.00	8.90	9.20
2: 2	**Control**	55.67	56.67	11.67	10.67	6.13	6.17
	15	56.67	56.33	14.67	15.00	8.43	7.87
	30	56.33	57.67	14.00	17.00	9.27	7.97
	45	59.67	59.67	15.33	20.00	9.13	8.80
2: 3	**Control**	50.33	46.33	15.33	17.00	6.80	7.40
	15	46.33	48.67	17.33	16.67	7.53	7.70
	30	55.67	53.00	16.00	18.00	8.63	8.40
	45	62.67	56.33	17.00	17.67	8.73	8.77
LSD at 5%		**4.62**	**3.17**	**2.27**	**1.96**	**0.99**	**0.57**

Table 4. Impact of intercropping system, phosphorus rate and their combination treatments on yield components of coriander plant during both seasons

Treatments		Umbel number/ plant		Fruit yield / plant (g)		Fruit yield/ feddan (kg)	
		1st season	2nd season	1st season	2nd season	1st season	2nd season
Effect of intercropping system (Coriander row: Fenugreek row)							
Sole coriander		34.08	33.25	10.63	10.23	1020.0	982.4
1: 1		39.33	39.58	14.05	13.47	674.4	646.3
2: 2		38.50	40.58	14.48	14.43	694.8	692.8
2: 3		39.58	40.42	17.78	17.68	682.6	678.7
LSD at 5%		**1.01**	**1.56**	**0.26**	**0.35**	**18.15**	**18.61**
Effect of phosphorus fertilizer rate (kg P_2O_5 /feddan)							
Control		34.67	34.50	10.78	10.72	594.7	583.7
15		38.17	38.17	14.15	13.47	754.6	728.6
30		38.33	39.83	15.38	15.02	830.2	801.5
45		40.33	41.33	16.61	16.51	892.2	886.4
LSD at 5%		**1.37**	**0.96**	**0.41**	**0.35**	**21.98**	**20.73**
Effect of intercropping system × phosphorus fertilizer rate							
Sole coriander	**Control**	29.00	26.33	9.03	8.47	867.2	812.8
	15	34.67	33.33	9.93	9.97	953.6	956.8
	30	34.33	35.67	11.43	10.60	1097.6	1017.6
	45	38.33	37.67	12.10	11.90	1161.6	1142.4
1: 1	**Control**	34.67	35.00	10.10	10.03	484.8	481.3
	15	40.33	39.33	13.73	13.13	659.2	630.4
	30	40.67	41.00	15.70	14.63	753.6	702.4
	45	41.67	43.00	16.67	16.07	800.0	771.2
2: 2	**Control**	38.00	40.00	11.10	10.93	532.8	524.8
	15	38.33	41.00	14.57	13.60	699.2	652.8
	30	38.00	40.67	15.50	15.47	744.0	742.4
	45	39.67	40.67	16.73	17.73	803.2	851.2
2: 3	**Control**	37.00	36.67	12.87	13.43	494.1	515.8
	15	39.33	39.00	18.40	17.57	706.6	674.6
	30	40.33	42.00	18.90	19.37	725.8	743.7
	45	41.67	44.00	20.93	20.33	803.8	780.8
LSD at 5%		**2.58**	**2.28**	**0.76**	**0.70**	**42.10**	**40.35**

Table 5. Impact of intercropping system, phosphorus rate and their combination treatments on yield components of fenugreek plant during both seasons

Treatments		Pods number/ plant		Seed yield / plant (g)		Seed yield/ feddan (kg)	
		1st season	2nd season	1st season	2nd season	1st season	2nd season
Effect of intercropping system (Coriander row: Fenugreek row)							
Sole fenugreek		27.67	29.17	9.61	9.42	922.48	904.32
1: 1		29.58	27.50	10.45	10.32	501.52	495.28
2: 2		31.83	31.50	10.34	10.38	496.52	498.28
2: 3		34.92	37.50	10.91	11.08	628.13	638.11
LSD at 5%		**0.96**	**1.05**	**0.16**	**0.06**	**9.21**	**4.14**
Effect of phosphorus fertilizer rate (kg P_2O_5 /feddan)							
Control		26.67	27.50	10.01	9.94	619.43	613.34
15		30.58	30.83	10.15	10.10	627.54	623.95
30		32.50	33.08	10.45	10.50	643.08	644.66
45		34.25	34.25	10.70	10.65	658.60	654.04
LSD at 5%		**0.99**	**0.77**	**0.09**	**0.05**	**5.03**	**3.00**
Effect of intercropping system × phosphorus fertilizer rate							
Sole fenugreek	**Control**	23.00	25.33	9.40	9.19	902.08	881.92
	15	26.00	28.67	9.51	9.37	913.28	899.52
	30	29.33	30.33	9.68	9.50	929.28	911.68
	45	32.33	32.33	9.85	9.63	945.28	924.16
1: 1	**Control**	24.33	23.67	10.08	10.09	483.68	484.16
	15	28.33	26.00	10.39	10.24	498.88	491.36
	30	32.67	29.33	10.63	10.41	510.40	499.84
	45	33.00	31.00	10.69	10.54	513.12	505.76
2: 2	**Control**	25.33	26.33	9.55	9.60	458.56	460.96
	15	30.00	31.00	9.73	9.74	466.88	467.68
	30	35.00	34.00	11.00	11.02	527.84	529.12
	45	37.00	34.67	11.10	11.15	532.80	535.36
2: 3	**Control**	34.00	34.67	11.00	10.87	633.41	626.30
	15	38.00	37.67	10.96	11.06	631.10	637.25
	30	33.00	38.67	10.50	11.08	604.80	638.02
	45	34.67	39.00	11.17	11.30	643.20	650.88
LSD at 5%		**1.94**	**1.69**	**0.22**	**0.10**	**12.62**	**6.62**

Competitive Indices: Land Equivalent Ratio (LER) and Aggressivity (A)

Intercropping influence

The competitive indices recorded in Table 6 show that coriander and fenugreek intercropped in 2: 3 system had higher land equivalent ratios (LER) (1.35 and 1.39) in 1st and 2nd seasons, respectively. This suggests that this intercropping system (2: 3) was advantageous for utilizing environmental resources. As can be seen from the aforementioned figures, which were more than 1.00, coriander and fenugreek intercropping at 1: 1, 2: 2, and 2: 3 was in fact more productive than growing them in sole planting system. According to **Natarajan and Willey (1980)**, the most often proposed explanation for this issue is that growth resources should be used rather differently such that they "complement" one another and efficiently use resources when developed together rather than individually. Also, **Dubey *et al.* (2023)** reported that chilli when intercropped with fenugreek recorded maximum LER.

An aggressivity value of zero is understood to signify equal competition between the component crops (Table 6). Two crops will have the same numerical value in any other scenario, with the dominant crop having a positive value and the defeated crop having a negative one. A higher numerical number indicates a wider disparity in competitive ability. In all intercropping systems, the coriander component interplanted with fenugreek (Ag for coriander) was the aggressor crop. For Ag for coriander plants, the greatest values of aggressivity were 0.531 and 0.546 with intercropping system 2: 3, whereas, for Ag fenugreek plants, the equivalent figures were -0.531 and -0.546 in the 1st and 2nd seasons, respectively. Likewise, **Li *et al.* (2024)** found that tiger nuts (*Cyperus esculentus* L.) crop was the dominant, whereas maize, soybean and cotton were the defeated ones.

Phosphorus influence

All values of LER were greater than one with any phosphorus fertilizer application (Table 6). Phosphorus rates significantly influence on land equivalent ratio compared to control. It is evident from the aggressivity numbers that fenugreek was the defeated crop and dill was the dominating one. Additionally, the degree of intra-crop versus inter-crop competition is the primary determinant of the benefit of growing coriander and fenugreek together. When companion crops use growth nutrients (such phosphorus) differently, there is less inter-crop competition compared to intra-crop competition. Similar results are noticed by **Abdelkader and Hassan (2016)** on dill when intercropped with fenugreek and combined with phosphorus fertilization.

Combination between intercropping and phosphorus influence

The combination treatment between intercropping system (two rows of coriander alternating with three ridges of fenugreek) with 15 kg P_2O_5 /feddan produced the highest LER (1.43 and 1.41) in both seasons, respectively (Table 6). Based on this data, it is possible to produce the same yield from one feddan utilizing this intercropping systems and 15 kg P_2O_5/feddan, which would take roughly 1.43 or 1.41 feddan if each crop were grown alone. When a 2:3 intercropping system treatment and 15 and 30 kg of P_2O_5 per feddan were utilized in the 1st and 2nd seasons, respectively, the aggressivity achieved its maximum values (0.701 and 0.663). According to the results above, the superiority in coriander and fenugreek fruit and seed yield by phosphorus fertilizer application can be directly attributed to the plants' improved yield components (Tables 4 and 5). This led to increases in metabolites synthesized to fruits and seeds, which in turn increased the total yield of coriander and fenugreek fruit and seeds, respectively. Phosphorus fertilization enhances growth, yield and LER in non-legume intercropping systems while legume-based intercropping may be more favorable under low phosphorus availability conditions (**Rahman *et al*., 2025 and Tao *et al*., 2025**).

Table 6. Impact of intercropping system, phosphorus rate and their combination treatments on LER and aggressivity values between coriander and fenugreek plants during both seasons

Treatments		Land equivalent ratio (LER)		Ag for coriander		Ag for fenugreek	
		1st season	2nd season	1st season	2nd season	1st season	2nd season
Effect of intercropping system (Coriander row: Fenugreek row)							
Sole crop		1.00	1.00	+ 0.000	+ 0.000	- 0.000	- 0.000
1: 1		1.20	1.20	+ 0.226	+ 0.214	- 0.226	- 0.214
2: 2		1.22	1.25	+ 0.283	+ 0.301	- 0.283	- 0.301
2: 3		1.35	1.39	+ 0.531	+ 0.546	- 0.531	- 0.546
LSD at 5%		**0.02**	**0.02**	**0.027**	**0.036**	**0.027**	**0.036**
Effect of phosphorus fertilizer rate (kg P_2O_5 /feddan)							
Control		1.12	1.16	+ 0.130	+ 0.184	- 0.130	- 0.184
15		1.23	1.21	+ 0.359	+ 0.284	- 0.359	- 0.284
30		1.20	1.25	+ 0.266	+ 0.312	- 0.266	- 0.312
45		1.21	1.23	+ 0.286	+ 0.281	- 0.286	- 0.281
LSD at 5%		**0.02**	**0.02**	**0.042**	**0.040**	**0.042**	**0.040**
Effect of intercropping system × phosphorus fertilizer rate							
Sole crop	**Control**	1.00	1.00	+ 0.000	+ 0.000	- 0.000	- 0.000
	15	1.00	1.00	+ 0.000	+ 0.000	- 0.000	- 0.000
	30	1.00	1.00	+ 0.000	+ 0.000	- 0.000	- 0.000
	45	1.00	1.00	+ 0.000	+ 0.000	- 0.000	- 0.000
1: 1	**Control**	1.09	1.14	+ 0.047	+ 0.087	- 0.047	- 0.087
	15	1.24	1.21	+ 0.290	+ 0.266	- 0.290	- 0.266
	30	1.24	1.24	+ 0.277	+ 0.286	- 0.277	- 0.286
	45	1.23	1.22	+ 0.292	+ 0.256	- 0.292	- 0.256
2: 2	**Control**	1.12	1.17	+ 0.213	+ 0.246	- 0.213	- 0.246
	15	1.24	1.20	+ 0.444	+ 0.326	- 0.444	- 0.326
	30	1.25	1.31	+ 0.220	+ 0.300	- 0.220	- 0.300
	45	1.26	1.32	+ 0.256	+ 0.331	- 0.256	- 0.331
2: 3	**Control**	1.27	1.35	+ 0.258	+ 0.403	- 0.258	- 0.403
	15	1.43	1.41	+ 0.701	+ 0.582	- 0.701	- 0.582
	30	1.31	1.43	+ 0.569	+ 0.663	- 0.569	- 0.663
	45	1.37	1.39	+ 0.595	+ 0.536	- 0.595	- 0.536
LSD at 5%		**0.04**	**0.04**	**0.04**	**0.077**	**0.078**	**0.077**

Conclusion

According to this study, in Sharkia Governorate conditions, farmers should employ a coriander/fenugreek association rather than a coriander or fenugreek sole crop, particularly when using a 2:3 cropping system. Increases in coriander and fenugreek growth and yield with the maximum land equivalent ratio were achieved by utilizing the phosphorus rates for both crops in the 2: 3 intercropping system at 15 P2O5 kg/feddan rate. .

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تأثير معدل التسميد الفوسفاتي على نمو وإنتاجية وبعض مؤشرات التنافس بين الكزبرة والحلبة تحت نظم التحميل في خطوط

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أُجريت تجربة حقلية في مزرعة خاصة، منطقة أبو حماد، محافظة الشرقية، مصر، خلال موسمي الشتاء (2024/2023 و2025/2024) وذلك لتقييم تأثير معدلات مختلفة من التسميد الفوسفاتي (صفر، 15، 30 و45 كجم فو2أ5/فدان) ونظم التحميل (الزراعة المنفردة لكلا المحصولين ككنترول، و1: 1 ، 2: 2، و2: 3 كنسبة بين خطوط الكزبرة والحلبة، على التوالي). وقد وزعت معاملات نظم التحميل في القطعة الرئيسية، بينما وزعت معدلات السماد الفوسفاتي في القطعة الفرعية بتصميم قطعة منشقة مرة واحدة في ثلاث مكررات. وقد أوضحت النتائج أن نباتات الكزبرة والحلبة الأطول قد تم الحصول عليها تحت نظام التحميل 2: 2 مقارنةً بالأنظمة الأخرى قيد الدراسة. كما لوحظ أعلى عدد من الأفرع وأعلى وزن جاف للعشب وإنتاجاً للثمار لكل نبات في الكزبرة عند تبادل خطين من الكزبرة مع 3 خطوط من الحلبة. وفي ظل نفس نظام التحميل (نظام 2 :3)، سجل نبات الحلبة أعلى عدد للقرون وأعلى إنتاج للبذور لكل نبات مقارنةً بنظم التحميل الأخرى. وقد أدى تسميد نباتات الكزبرة والحلبة بمعدل 45 كجم فو2أ5/ فدان إلى زيادة معنوية في صفات النمو والإنتاجية مقارنةً بأي معدل من معدلات الفوسفور قيد الدراسة. بشكل عام، تم الحصول على أعلى قيم لنسبة المكافئ الأرضي (1.35 و1.39) في نظام 2:3. وكانت أفضل معاملة تداخل فيما يتعلق بمعامل المكافئ الأرضي (1.43 و1.41) هي نظام تحميل 2: 3 مع 15 كجم فو2أ5/فدان. وكانت نباتات الكزبرة هي المحصول السائد (تحمل اشارات إيجابية)، بينما نباتات الحلبة هي المحصول المسود عليه (تحمل اشارات سالبة)..

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